REMARKS

Applicants respectfully request further examination and reconsideration in view of the above amendments and the comments set forth fully below. Claims 12-21 were pending. Within the Office Action, Claims 12-21 have been rejected. By the above amendment, Claims 12 and 19 have been amended and Claim 18 has been canceled. Accordingly, Claims 12-17 and 19-21 are now pending.

In order to distinguish the features of the present application from those of the cited references more clearly, the independent Claim 12 has been amended based on the description included within at least Paragraph [0032] of the present specification. Accordingly, such an amendment is supported by the specification of the present invention, and therefore there is no new matter added therein.

Rejections Under 35 U.S.C. § 102

Within the Office Action, Claims 12-15, 17-19 and 21 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent Publication No. US 2003/0143772 A1 to Chen (hereinafter referred to as "Chen"). Regarding Claim 12, it is asserted within the Office Action that all of the technical features thereof are disclosed in Figure 6C of Chen.

What is asserted within the Office Action is that Chen discloses a light emitting diode, which comprises a semiconductor structure for emitting light 104, 106, 108 (paragraph [0023], lines 4-8), a transparent substrate 120 (paragraph [0028], lines 3-5) formed on the semiconductor structure via a metal bonding layer 124 (paragraph [0028], line 13) between the semiconductor structure and the transparent substrate, and a first electrode 130 (paragraph [0030], line 3) and a second electrode 122 (paragraph [0028], line 11) respectively formed on the semiconductor structure and the transparent substrate for providing a current to the semiconductor structure.

Chen discloses a high efficiency light emitting diode (LED) with a metal reflector and the fabrication method therefor. The main technical feature of Chen exists in that the metal reflector is composed of at least two layers including one transparent conductive layer and one highly reflective metal layer. <u>The transparent conductive layer allows most of the light to pass through without being absorbed and then being reflected back by the highly reflective metal layer.</u>

According to Paragraph [0023] of Chen, an epitaxial structure 118 of a light emitting structure consists of a temporary GaAs substrate 100, an etching stop layer 102, an n-type $(Al_xGa_{1-x})_{0.5}In_{0.5}P$ lower cladding layer 104 with an Al composition of about 50%-100%, an $(Al_xGa_{1-x})_{0.5}In_{0.5}P$ active layer 106 with an Al composition of about 0%-45%, a p-type $(Al_xGa_{1-}$

$_{x})_{0.5}In_{0.5}P$ upper cladding layer 104 with an Al composition of about 50%-100%, and a p-type ohmic contact layer 110. As one skilled in this art knows, such a layered structure is a common structure for the light emitting diode.

According to Paragraph [0028] of Chen, the mentioned epitaxial structure 118 is then bonded to another high thermal and electrical conductive substrate 125. Based on Figure 6B of Chen, the high thermal and electrical conductive substrate 125 includes a highly doped silicon substrate 120 and two ohmic contact metal layers 122, i.e. electrodes, on both sides thereof. Besides, either side of the ohmic contact metal layer 122 is bonded with the epitaxial structure 118 by a metal bonding layer 124.

After bonding, the absorption GaAs substrate 100 is removed by mechanical lapping, chemical etching, or reactive ion etching. Subsequently, an n-type ohmic contact 130 is deposited on the etching stop layer 102 and annealed to complete a vertically current conducting AlGaInP light emitting diode with good heat dissipation.

Based on the teachings of Chen, it is apparent that the metal bonding layer 124 is applied to either side of the ohmic contact layer 122 on the highly silicon substrate 120 for bonding the ohmic contact layer 122 with the epitaxial structure 118.

For enhancing the light-emitting efficiency, it is a common scheme for the skilled person to replace the light absorbing GaAs substrate with a transparent substrate. However, it is always a difficult thing to optimize the procedures of the fabrication method.

The present application provides a novel LED whose light-emitting efficiency is unaffected even though the LED is driven at a high current level. In the present application, the procedures for fabricating the LED and the provided structure thereof are typically different from those taught by Chen. According to the present application, the metal bonding layer 12 is formed on the semiconductor structure 11 which is a light emitting diode structure.

With the conditions that the bonding temperature is controlled within a range of 300 °C to 900 °C, preferably 400 °C to 700 °C, and the bonding pressure is controlled within a range of 500 pounds to 5000 pounds, preferably 1500 pounds to 3500 pounds, the transparent substrate 13 of the present application is bonded with and ohmically contacted with the semiconductor structure 11 via the metal bonding layer 12 formed thereon. Then a p-type electrode 14 and an n-type electrode 15 are respectively formed on the transparent substrate 13 and the semiconductor structure 11 after the growing GaAs substrate 10 is removed, and the whole LED structure is thus provided.

In comparison with the teachings of Chen, the main distinguishable feature exists in the position and thus the application of the metal bonding layer. Regarding the present application,

the metal bonding layer is formed on the semiconductor structure for bonding the semiconductor structure to the transparent substrate, while Chen teaches that the metal bonding layer is formed on either side of the ohmic contact layer of the conductive substrate, and the whole epi-wafer, i.e. the epitaxial structure, is bonded to the conductive substrate. That is to say, the bonding technology adopted in Chen relates to a wafer bonding technology whose procedures and bonding conditions are more complicated and critical than those adopted in the present application. In the present application, the metal bonding layer is formed directly on the semiconductor structure and serves as a bonding layer as well as an ohmic contact between the semiconductor structure and the transparent substrate. Therefore, it is not necessary to provide an additional ohmic metal layer on the conductive substrate, so that the light-emitting efficiency is able to be further enhanced and the volume of the whole LED structure is capable of being decreased.

Furthermore, the bonding conditions of the metal bonding technology adopted in the present application are also more beneficial to be performed. Since the layered structure that the metal bonding layer formed directly on the semiconductor structure is more simplified, it is hence achievable to decrease the bonding temperature as well as the bonding pressure, so as to perform the metal bonding technology in a simplified and efficient way. Compared with the conventional wafer bonding technology, the metal bonding temperature is decreased from the range of 850-1000 °C to the range of 300 °C to 900 °C. Therefore, the production cost is able to be efficiently reduced through the present application and the yield is increased.

Based on the above explanations, it is apparent that the technical features of the present application are distinguished from those of the cited reference. Therefore, the Applicant respectfully submits that the amended Claim 12 is patentable over the teachings of Chen.

Specifically, the independent Claim 12 is directed to a light emitting diode structure. The light emitting diode structure of Claim 12 comprises a semiconductor structure for emitting light, a metal bonding layer on the semiconductor structure, a transparent substrate formed on said metal bonding layer and bonded with said semiconductor structure under a bonding temperature ranged from 300 °C to 900 °C and a first electrode and a second electrode respectively formed on said semiconductor structure and said transparent substrate for providing a current to said semiconductor structure. As described above, Chen does not teach a metal bonding layer on the semiconductor structure. As also described above, Chen does not teach a transparent substrate formed on said metal bonding layer and bonded with said semiconductor structure under a bonding temperature ranged from 300 °C to 900 °C. For at least these reasons, the independent Claim 12 is allowable over the teachings of Chen.

By the above amendment, Claim 18 has been canceled. Claims 13-15, 17, 19 and 21 are all dependent on the independent Claim 12. As discussed above, the independent Claim 12 is allowable over the teachings of Chen. Accordingly, Claims 13-15, 17, 19 and 21 are all also allowable as being dependent on an allowable base claim.

Rejections Under 35 U.S.C. § 103

Within the Office Action, Claim 16 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen in view of U.S. Patent No. 4,712,478 to Sheu et al. (hereinafter referred to as "Sheu"). It is asserted within the Office Action that Chen teaches that the transparent substrate is SiC and Sheu teaches that the substrate can be SiC or GaP. It is then concluded within the Office Action that it is obvious to the skilled person to modify Chen by having the transparent substrate of GaP for the purpose of obtaining a specific application and design of a light emitting structure. The Applicant respectfully disagrees.

Sheu discloses a light emitting diode (LED) with strained layer superlattice (SLS) crystal structure formed on a provided substrate 100, wherein a nucleation layer and a buffer layer are sequentially formed on the substrate 100 so as to ease the crystal growth for the subsequent crystal growing process. An active layer including III-V group compound semiconductive material is covered between an upper cladding layer and a lower cladding layer, and an SLS contact layer is located on the upper cladding layer. Besides, a transparent electrode is located on the contact layer so as to serve as an anode, and another electrode layer has a contact with the buffer layer and is separated from the lower and the upper cladding layers.

It is apparent that the substrate 100 including sapphire, SiC, ZnO, Si, GaP, GaAs or Al_2O_3 in Sheu serves as a growing substrate 10, such as the GaAs substrate, in the present application, but not the transparent substrate 13 therein. In addition, the layer growth process in Sheu relates to a conventional epitaxial growth process which involves more complicated procedures and needs to be further simplified. Such a process and thus the provided structure are typically different from those of the present application and are already mentioned therein. That is to say, even if the GaAs substrate serving as the growing substrate is replaced by a GaP substrate in Sheu, it still needs a lot of complicated procedures and conditions to perform the epitaxial growth process so as to achieve the formation of the LED structure thereon.

In contrast, the present application provides a novel scheme and LED structure for overcoming the mentioned problem. The provided structure includes a novel metal bonding layer on the semiconductor structure, i.e. the light emitting structure, for bonding the light emitting structure to a transparent substrate. The light emitting structure is primarily formed on

the growing substrate which would be further removed in a following step. The metal bonding layer provided in the present application makes it possible to utilize a transparent substrate to replace a conventional light-absorbing substrate in a much simplified way, so that the photons emitted downwardly from the LED would not be absorbed thereby.

As compared to the teachings of Sheu, the LED provided in the present application is advantageous in the lateral emission with a height of almost 250 mm and the high reflective index of the bonding metal, so that the output power thereof is efficiently improved. Besides, the metal bonding technology adopted in the present application is more applicable than the conventional process adopted in Shue due to its simplified procedures. The Applicant respectfully points out that the novelty and the improvement of the metal bonding layer on the semiconductor structure in the present application should thus be prominent. For at least these reasons, Claim 16 is patentable over the teachings of Chen, Sheu and their combination.

As an alternative basis for allowability, Claim 16 is dependent on the independent Claim 12. As discussed above, the independent Claim 12 is allowable over the teachings of Chen. Accordingly, Claim 16 is also allowable as being dependent on an allowable base claim.

Within the Office Action, Claim 20 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen. Claim 20 is dependent on the independent Claim 12. As discussed above, the independent Claim 12 is allowable over the teachings of Chen. Accordingly, Claim 20 is also allowable as being dependent on an allowable base claim.

Should the Examiner have any questions or comments, they are encouraged to call the undersigned at (408) 530-9700 to discuss the same so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
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CERTIFICATE OF MAILING (37 CFR§ 1.8(a))

I hereby certify that this paper (along with any referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450

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